RSIDIS Analysis Meeting 2026-10-19 12:00(GMT-4:00)

Key Outcomes

The meeting centered on three main areas: a detailed walkthrough of the SIMC Monte Carlo input file configuration for semi-inclusive DIS (SIDIS) analysis, ongoing data quality issues (HMS lifetime discrepancy affecting 72 Phase 1 runs), and updates on detector studies including RF time-based PID and HMS/SHMS acceptance corrections. Key configuration decisions were made for radiative corrections, collimator simulation, and kinematic offsets, with action items assigned to prepare corrected SIMC input files and fix the Big Table lifetime values.

Decisions Made

- **SIMC eGammaGenMax flag** must be set close to beam energy (e.g., 8,000 MeV) for SIDIS, overriding the dynamic per-event calculation, because a small but non-negligible difference was found between the two methods for semi-inclusive DIS (no difference was found for exclusive pion production).
- **Using_ELOS** set to 1 (simulate ionization energy loss) but correction flag set to 0, because HCana does not apply an energy loss correction — unlike the old analyzer.
- **Target_M_recoil** must always be 0 for SIDIS.
- **Target_can = 3** required for 12 GeV-style 10 cm cryogenic cells.
- **Fast_raster_pattern = 3** selected for flattest distribution; triangular waveform produces flat spatial distribution (square waveform caused corner pile-up in older data).
- **Using_Coulomb_corrections** should be enabled for nuclear targets (accelerates/decelerates particles in nuclear Coulomb field); has no effect for hydrogen/deuterium.
- **SHMS_collimator flag** (using_SHMScoll) confirmed to be correctly calling the collimator subroutine after verification during the meeting; hadronic interactions are simulated in ~20 steps through the collimator material.
- **Rho production** Monte Carlo: only needs to be run once for one charge (π^+ or π^-) since both charges from ρ decay are symmetric — saves computation time.

- **which_pion flag** is irrelevant for SIDIS; only doing_semi and H_plus together control the pion charge in SIDIS.
- **doing_rho** flag completely overrides doing_semi, which_pion, and related flags.
- **HMS lifetime formula**: replace H.TTRIG2.scaler with H.EL_REAL.scaler in the template for all future replay passes; Phase 1 cannot be reprocessed — Big Table will be manually corrected for the 72 affected runs.
- **Kinematic settings table**: a consolidated, agreed-upon list of SIDIS settings must be presented at the next Thursday meeting.
- **XPTAR/YPTAR correction grid**: rather than fitting smooth surfaces, a direct bin-by-bin correction factor grid (20 bins × 20 bins in XPTAR × YPTAR, per Δ bin) will be used without interpolation.
- **Positron background subtraction**: bin-by-bin subtraction is not feasible due to insufficient statistics; a global average fractional subtraction (~2%) is the practical approach.

SIMC Input File Configuration Details

Semi-Inclusive DIS Setup

- Key flags: doing_semi = 1, doing_pion specifies meson type (Pion or Kaon only currently functional).
- doing_pi_zero defaults to 0 and can be deleted; pi_zero and gamma flags unnecessary for charged pion SIDIS.
- H_plus = 1 for π^+, H_plus = 0 for π^- in SIDIS.
- doing_pion flag does double duty: originally for exclusive pion production, now also specifies the meson type for SIDIS.

Exclusive Pion Production (Background Estimation)

- doing_semi = 0, doing_pion = 1, which_pion controls charge: 0 = π^+ from proton, 1 = π^- from neutron, 2 = π^+ from Δ, 3 = π^- from Δ.
- H_plus flag is irrelevant for exclusive pion production — charge is entirely controlled by which_pion.

Generation Volume Settings

- Generation limits in X′, Y′, and Δ must be **wider than the physical acceptance** to allow events originating outside acceptance to scatter in.

- Recommended check: run ~10,000 events, inspect the hist file for the range of accepted events — if accepted events reach the generation boundary in X′ or Y′, the limits are too tight.
- Δ limits: ±8% cuts will be applied anyway, so boundary effects there are less critical.

Offsets to Include

- **Beam position offsets** (X, Y): from beam position data — targ_X/Y_offset in SIMC are actually beam offsets.
- **Spectrometer X/Y pointing offsets**: from survey data (not the XPTAR reconstruction correction, which is separate).
- **Target Z offset**: from analysis by Ryan and Vishma for Phase 1 and Phase 2 run groups.
- Central kinematic offsets (momentum, angle) go into the **central kinematic settings**, not a separate offset field.
- Ryan's e-logbook entry (~8 months old) may not include Phase 2 / New Year's data — needs verification.

Radiative Corrections Flags

- using_rad = 1, using_expon = 0, one-tail flag enables photon radiation for incoming electron, outgoing electron, and outgoing hadron.
- into_core_mode = 1 (best internal corrections mode).
- using_off_shell_rad = 1: allows the virtual intermediate particle to be off-shell.
- An additional flag (name not recalled during meeting) beyond eGammaGenMax should also be included — Dave noted it exists in Dbase/Simpson.

Solid vs. Cryo Target Handling

- Open question: whether SIMC treats a solid target (e.g., carbon) like a cryo target when a target_can and density are specified — someone needs to verify this.
- Rho production (doing_rho) likely only works for proton; nuclear target cross sections not implemented — rho background subtraction for nuclear targets remains an open problem.

HMS Lifetime Discrepancy (Phase 1 Data Quality)

- **Root cause**: the lifetime formula in the replay template used H.hTRIG2.scaler, which showed significant discrepancy from H.hEL_REAL.scaler for 72 Phase 1 runs.
- **Scale of problem**: 72 out of ~1,500 Phase 1 runs affected with non-negligible discrepancy; only 4 Phase 2 runs showed discrepancy of magnitude 1–2 (negligible).

- **Fix for future passes**: template already updated to use H.hEL_REAL.scaler; confirmed correct by replaying 10,000 events on an affected run.
- **Immediate fix**: manually patch the Big Table values for the 72 affected runs using H.hEL_REAL.scaler values.
- Ryan noted his own cross-check found ~15 runs with >1% lifetime discrepancy — likely a subset, possibly further reduced by scalar vs. scalar-cut differences (numerator uses H_cut_physics_accepted class without BCM cut).

XPTAR/YPTAR Acceptance Correction (Ryan)

- Ryan reworked his analysis framework to compute **data-to-MC ratios** across a 3D grid: 20 bins in XPTAR × 20 bins in YPTAR × Δ bins.
- Each grid point aggregates 5 kinematic settings (4-pass and 5-pass from last year; 3-pass, 4-pass, 5-pass from this year), normalized to a common value.
- **Pull distribution** (should resemble unit Gaussian centered at zero) used to diagnose overfitting/underfitting of any surface model.
- Surface fitting found to produce weird behavior in some regions; direct bin-by-bin correction grid preferred by Dave — no interpolation needed.
- 2025 data alone yields better-behaved fits, likely due to more corrections applied.
- **Next step for Ryan**: generate the correction factor matrix; this is a service product for the SIDIS analysis team, not part of Ryan's own physics analysis (though it can serve as a systematic cross-check against his 1D Δ polynomial correction).
- **Future work**: extend to SHMS singles data taken last year.
- Different correction factors likely needed for cryo vs. solid targets — not yet robustly explored.

SIDIS Cross-Section Analysis (Provakar / Radwan)

- Negative cross-section values traced to bins in φ_PQ–P_T space with insufficient statistics — those bins should be excluded by first inspecting the 5PQ–PT 2D distributions and making manual bin-by-bin inclusion decisions.
- Recommended display strategy: plot one Z value per page (e.g., Z=0.36, then Z=0.50) rather than overlaying all Z settings, since adding multiple θ_PQ settings later will make combined plots even busier.
- φ binning: 16–20 bins over 0 to 2π recommended; Peter uses 15 bins (per Julio); current plots use inconsistent binning that needs to be unified.

- PT binning: 20 bins from 0 to 0.6 GeV used for data-to-MC comparison.
- Positron runs: some runs yield negative good-coincidence event counts — set those to zero; do not subtract positron background bin-by-bin.
- Z = 0.9 setting was a special test to constrain radiative corrections via exclusive yield — should **not** be included in the standard SIDIS analysis.
- Plot improvements needed: increase marker size, reduce line width, add slight transparency, consider jittering points in X to resolve overlapping.
- With only ~5 X–Q^2 settings and ~3 θ_{PQ} settings, manual bin selection is practical and preferable to automated cuts for this dataset size.

Kinematic Settings Table Discrepancy

- Provakar independently reconstructed the SIDIS kinematic settings list from run plans; Julio built his from run plans plus additional entries not found in run plans.
- All runs fall into at least one setting from the combined list, but some settings differ slightly (e.g., nominal value 0.5 but run taken at 0.6).
- Example ambiguity: $\theta_{PQ} = -0.2$ vs. $\theta_{PQ} = 0$ — whether these are the same setting or distinct requires a tolerance decision.
- **θ_{pq} = -0.2 and 0** — Dave's guidance: do not combine them; keep $\theta_{PQ} = -0.2$ as its own setting.
- Intentional θ_{PQ} values confirmed: +2, −0.8 (standard), 5.8 (P_T scan).

RF Time and PID Studies (Zichen)

- **Bunch spacing issue**: HCana RF time class has hardcoded bunch spacing of 4.008 ns, but 3-pass and 4-pass runs this year used 2 ns spacing — configurable via bunch_spacing_override in the param file.
- **Offset variability**: the RF time offset is not constant — the populated bunch can shift between runs (injector-driven), requiring per-run offset checks and param file updates.
- RF time useful for PID (separating protons from kaons/pions) up to ~4.4 GeV SHMS central momentum with 4 ns bunch spacing; Dave noted surprise it works that well.
- **Aerogel cut**: cut below NPE ~5 appears reasonable for proton selection; combined with RF time timing cut to further reject pions and kaons.
- **HGC cut**: NPE ~2–3 appears reasonable; hole region must be excluded — a detailed efficiency/contamination study would be needed for more quantitative cuts, but is complex.

- **Next step**: add RF time class and relevant branches to local build, add bunch spacing param variable, replay 1–2 runs, compare with existing results; if consistent, include in next replay pass.
- Invariant mass W vs. coincidence time is uncorrelated — 2D plot adds no information; use 1D coincidence time plot instead.

Single-Spin Asymmetry Paper Status

- Preliminary results shown with systematic uncertainty bands; CLAS12 data (blue points) consistent with Hall C results.
- **Two remaining systematics to address**:
  - Nuclear dependence of exclusive process: currently assumed same as hydrogen with a flat ~20% correction for lack of color transparency — needs more careful quantification using transparency data available at this kinematic setting (reference: Yinchun/Ben Clasie & Dipankar Datta PRL + PRC papers).
  - Rho production background: no data available for nuclear targets; plan is to estimate fractional contribution from hydrogen Monte Carlo and note the uncertainty for nuclear targets.
- Plot quality: content approved; label sizes need to be increased for paper submission.

Random Coincidences and Bunch Structure (Discussion)

- Question raised: can two real events from the same bunch produce a fake coincidence (electron from event A, hadron from event B, both real)?
- Answer: probability is vanishingly small; even if it occurred, it would be captured in the **dead time correction**.
- Standard random coincidence subtraction (sampling random peaks) handles the case where one particle is real and the other is accidental.

Pending Confirmation

- Whether SIMC correctly handles **solid targets** (e.g., carbon) differently from cryo targets when target_can and density are specified — Dave volunteered to verify.
- Whether doing_rho works for **nuclear targets** in SIMC (currently suspected proton-only).

- Ryan to check whether his e-logbook entry covers **Phase 2 / New Year's run** kinematic offsets.
- Whether different XPTAR/YPTAR correction factors are needed for **cryo vs. solid targets** — not yet robustly explored.
- The exact name of the additional radiative correction flag (beyond eGammaGenMax) that should be added to the SIDIS input file.

Open Questions

- If hydrogen data exists for a kinematic setting but deuterium data does not, analysis proceeds for hydrogen only — no resolution for missing deuterium settings.
- Rho background subtraction strategy for nuclear targets remains unresolved pending SIMC implementation.
- Optimal tolerance for grouping runs into the same kinematic setting (e.g., when nominal and actual spectrometer angle differ slightly).

Action Items

- **Julio + Radwan**: Prepare a complete SIMC SIDIS input file with all offsets (beam position, spectrometer pointing, target Z) included, for review at next Thursday's meeting.
- **Julio**: Present a consolidated kinematic settings table at Thursday's meeting for group agreement.
- **Provakar** → **Julio**: Share slides and list of 72 problematic runs; Julio to implement Big Table fix for HMS lifetime values.
- **Ryan**: Generate the XPTAR/YPTAR/Δ correction factor matrix (grid, no interpolation) for SIDIS analysis use.
- **Ryan**: Check and update e-logbook entry to include Phase 2 kinematic offset values.
- **Ryan**: Share list of problem runs (lifetime discrepancy) with Provakar for cross-comparison.
- **Zichen**: Add RF time class and bunch spacing param to local build; replay 1–2 runs and compare with existing results before including in next pass.
- **Vishma**: Continue HMS admittance comparison work (analogous to Ryan's XPTAR/YPTAR study).
- **Dave/Provakar**: Verify solid target handling in SIMC.
- **Provakar**: Quantify nuclear color transparency correction for single-spin asymmetry paper using transparency data and Clasie/Datta papers.

Next Meeting

Thursday (regular weekly meeting); Dave will chair. Julio to present kinematic settings table; SIMC input files with offsets to be reviewed.

Other Notes

- **$\pi^+ \pi^-$**
- **$\pi^+ \pi^- \pi^+ \Delta \pi^- \Delta$**
- **$\pi^+ \pi^+ \pi^-$**
- **σ_SIDIS, 5p_q, p_T, z**
- **x_PTAR, y_PTAR, Δ (appears twice in notes)**